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Agricultural Research




Regional Research Centers: Working Wonders

Technology Transfer Makes Business Sense

We'll always remember the eighties as a decade of dramatic change and auspicious promise. Let's also bear in mind that the decade brought to the federal research community a commitment to transfer the technological fruits of the laboratory to the private sector. Not since 1914, the year of the Smith-Lever Act establishing the Cooperative Extension Service, have Congress and the Executive branch shown such sensitivity to technology transfer.

With passage of the Stevenson-Wydler Act of 1980 and the Technology Transfer Act of 1986, Congress placed a new level of emphasis on commercialization of federal research. The Executive branch also weighed in with the Packard Commission's report on federal laboratories in 1983 and Presidential Executive Order 12591 of April 10, 1987. This time the main effort is to transfer technology developed by publicly funded research organizations such as the Agricultural Research Service to nonfarm businesses of all sizes and to state and local governments.

By tapping into the federal government's own wealth of science and technology, Congress acted to aid in the technological improvement of U.S. industry. In testimony given at a congressional hearing in fall of 1989, D. Allan Bromley, Director of the White House Office of Science and Technology, depicted a leadership role for federal research organizations such as ARS:

"The federal government's laboratories . . . embrace an astonishing breadth and depth of the best science and technology to be found. This base of knowledge represents one of our most valuable national assets. So to get full value out of our technology base, it must be put to use."

Throughout the eighties, ARS moved vigorously to implement the two recent Acts of Congress and Executive branch mandates to enhance technology transfer to both agribusinesses and others.

One of our most fundamental efforts was to establish an Office of Research and Technology Applications, as required by the 1980 law. This office directly reports to the ARS Office of Cooperative Interactions, headed by William H. Tallent, Assistant Administrator.

Formal arrangements called Cooperative Research and Development Agreements (CRADA's) now enable ARS scientists to cooperate with industrial scientists and bridge the gap between scientific research results and commercialized technological innovations. In the mere 2 years ARS has been empowered by law to do so, we have signed more than 100 of these agreements with industry firms. Two have already brought new technologies to the marketplace: a test kit that allows rapid detection of viruses in plants, and an in egg method for vaccinating chicks against Marek's disease before they hatch.

ARS' patent program has been reorganized to gather all patent-related jobs into one unit. Patent Review Committees were formed to prioritize inventions for patenting based on criteria developed by ARS' Office of Cooperative Interactions. Employees have been alerted to the benefits and requirements of the patent program.

Perhaps because of our new aggressiveness, industry interaction with ARS on patented research has never been higher. We're granting many exclusive or co-exclusive patent licenses. To get these licenses, industry pledges to commit a sizable investment to manufacture a variety of agricultural products useful for crop production, animal health, and pesticide control.

We've also attended to the motivational side of technology transfer. The improved climate and increased opportunities for moving their discoveries into practical applications stimulated ARS scientists to file 30 percent more invention reports in 1989 than in 1986. In 1989, ARS scientists earned $60,000 as their share of licensing fees and royalties from their inventions. There's also a program of awards for technology transfer: Scientists responsible for the successful transfer of new patented or unpatented technology can earn $500 to $2,500 each. In 1989, 15 ARS scientists were awarded a total of $11,500.

We've acted to improve service to traditional users of ARS research discoveries such as the State Cooperative Extension Services, the Soil Conservation Service, and farm and commodity organizations. The most important step in serving both traditional and new users is establishing communication between scientists and potential users. This step has been augmented by an electronic system, TEKTRAN, for collecting, storing, retrieving, and disseminating the latest ARS research discoveries to users, and by increased research reporting by the ARS Information Staff.

It all spells an increased emphasis on technology transfer in the 1980's, one that has already translated into some notable successes. In this issue of *Agricultural Research*, you'll find several stories that are cases in point, such as "Research Fuels Local Economies," by Matt Bosisio.

We think that everyone wins when ARS technology translates into the establishment of new enterprises, especially in rural areas where employment opportunities are badly needed.

R. D. Plowman
Administrator

Agricultural Research

Cover: From a way to mass-produce penicillin to more convenient foods and safer, easier to use agricultural products, the four ARS Regional Research Centers have contributed greatly to the quality of life. Story on page 4.

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WORKING WONDERS

For 50 years, the Regional Research Centers have been cooking up miracles. Here's a peek at a few.

Andrew Moyer, discoverer of the industrial process for mass-producing penicillin. Research at the Northern Regional Research Center opened the era of antibiotics in medicine.

In 1928, Alexander Fleming was studying *Staphylococci* bacteria in his laboratory at a London hospital. When a green mold contaminated one of his growth cultures, killing the bacteria around it, the 46-year-old Scots bacteriologist didn't do the natural thing and throw the ruined culture away.

Instead, he identified the mold as a species of *Penicillium* and began experimenting with the substance it produced, which he called penicillin. And he found that even when diluted as much as 800 times, penicillin still killed bacteria.

In 1929, Fleming published a paper describing his research in the "British Journal of Experimental Pathology" and then resumed his bacteriological studies, using penicillin as a laboratory tool to isolate microbes.

Not until more than a decade later, in 1940, did anyone begin to realize penicillin's potential as an antibiotic for human infections. Two scientists at Oxford University stumbled on the possibility as part of more general experiments. But their early efforts to produce penicillin in large batches and in pure form failed. And in the early stages of World War II, Britain had neither the money nor the facilities to devote to such risky research.

So in 1941, the Oxford scientists brought their problem to the United States and turned it over to the Fermentation Division at USDA's Northern Regional Research Laboratory in Peoria, Illinois.

The laboratory at Peoria was one of four opened in 1940. The other three are located in Philadelphia, Pennsylvania, New Orleans, Louisiana, and Albany, California, in the San Francisco Bay area.

The Agricultural Adjustment Act of 1938 had charged the Secretary of Agriculture with establishing the regional laboratories "to conduct researches into and to develop new scientific, chemical, and technical uses

and new extended markets and outlets for farm commodities and products and byproducts" of those commodities, especially those often produced in surplus.

Today the four laboratories are under the administration of ARS and have undergone two name changes—first to Utilization Research and Development Laboratory, and now to Regional Research Center.

Among the original residents of the Peoria laboratory were 1,200 mold strains that were the basis of the ARS Culture Collection, microorganisms that are or might be used in industrial processes—fermenting drugs, for example. Today that collection contains over 80,000 strains, which are available for research and development worldwide. But already in 1941, scientists in the Fermentation Division were producing industrial chemicals from some of the molds, such as itaconic acid (now used in making plastics, lubricants, and other chemicals) from about 30 different isolates of *Aspergillus terreus.*

Building on the basic research done at Oxford, the Peoria fermentation specialists, with help from the University of Wisconsin and the Carnegie Institute, developed an industrial method for mass-producing penicillin. The method they devised is called deep fermentation—growing an organism *in* the medium rather than on its surface.

Deep fermentation, a brewing-industry technique, was also used to mass-produce vitamins. The Peoria team refined and modified the method for use in high-volume production of penicillin. But their *Penicillium* strains were too fragile for deep fermentation.

Thousands of *Penicillium* strains exist in nature, so the scientists had many to choose from—and had many to isolate and test.

Thank You, Moldy Mary

They found the mold they needed on a rotting cantaloupe. It was brought in by a research assistant known to posterity as Moldy Mary because her duties included looking for molds on spoiled produce at a local market.

The cantaloupe mold was a strain of *Penicillium chrysogenum* that was added to the culture collection as NRRL 1951 B25.

By growing NRRL 1951 B25 in a revolving drum filled with the liquid

KEITH WELLER

Twenty-five years of research at the Western Regional Research Center resulted in better quality frozen foods. (K-3550-1)

from fermenting corn (as a growth medium), the Peoria researchers finally succeeded in producing quantities of stable, potent penicillin.

Drug and chemical companies had cooperated in various stages of the research, and they received patent licenses to use the process first to make penicillin for the military and then for civilians. By the end of World War II, American companies were making enough penicillin to meet worldwide needs, and their production refinements had already lowered the cost per individual treatment from $200 to $6.

The closest thing to a wonder drug that the 20th century has produced, penicillin has cured millions of infections and saved hundreds of thousands of lives. The companies that first manufactured it profited enormously and therefore had the money and the incentive for research and development leading to other antibiotics and drugs that prevent, treat, and control all kinds of acute and chronic illnesses.

Production of penicillin was the foundation of the modern, highly lucrative pharmaceutical industry. And development of deep fermentation as the production method was as important to the success of penicillin as the serendipity of its original discovery.

Shaping Life and Lifestyle

The penicillin story was a team effort that altered the course of modern medicine. But hundreds of other scientific success stories have also been set at the regional research centers. They too have profoundly affected the health of American agriculture and the quality of life for people the world over.

Many, many conveniences we take for granted—such as year-round orange juice, instant potato flakes, wrinkle-resistant cotton shirts, and high-quality frozen foods—owe much to work done at the regional research centers in the past 50 years.

Most of the projects at each of the centers are focused on developing and improving products from crops and livestock—processed foods, textiles and hides, and industrial chemicals, including food additives, pharmaceuticals, plastics, personal care products, and soaps and other cleansers.

The centers are also dedicated to ensuring food safety and to minimizing the effect of commodity storage and processing on the environment.

JACK DYKINGA

At the Southern Regional Research Center, technician Anastasia Hammond distills formaldehyde from cotton samples. (K-1864-18)

Today in America, orange juice is a commonplace breakfast drink. And it's good for you: A 6-ounce glass has only 90 calories, is high in potassium and vitamin A, and more than takes care of an adult's minimum daily requirement for vitamin C.

But 50 years ago, the only available orange juice was either canned (and tasted like can), concentrated (and when reconstituted, tasted like water), or fresh (but only in season). And Florida was producing plenty of surplus oranges.

In 1946, Louis G. MacDowell, director of research at the Florida Citrus Commission, figured out that adding a little fresh juice, or cut-back, to concentrated juice would restore the flavor and aroma lost during the concentration process. He and colleagues took the idea to USDA scientists at Winter Haven, Florida. The Winter Haven laboratory, then a field station of what is now the ARS Southern Regional Research Center in New Orleans, had the necessary equipment and expertise to help refine the process.

The Citrus Commission and USDA researchers also discovered that the concentrate could easily be frozen, and a new industry was born. Today, the frozen concentrated orange juice market is worth $400 million a year.

Putting the Plus in Surplus

Much of the food processing research at the regional research centers has followed the same developmental pattern: Take a market surplus, find a way to stretch its usefulness and it becomes a new convenience food.

Consider the potato. More potatoes are processed each year than any other fruit or vegetable. In the United States today, some 20 billion pounds of potatoes a year are commercially

Leftovers Again?

A new technology patented by U.S. Department of Agriculture scientists that effectively halts meat-flavor deterioration just may keep Junior from lodging a complaint with his mother.

Scientists Allen J. St. Angelo and John R. Vercellotti of USDA's Agricultural Research Service have found a way to control flavor loss from oxidation in meat, thus preserving desirable meat-flavor quality.

A derivative of chitin, the fibrous portion of shells from crab, shrimp, lobster, and crayfish, is used to inhibit iron in meat from reacting with oxygen. This prevents polyunsaturated fats from being broken into products that cause off-flavor in meat, says St. Angelo. The derivative used in the ARS technique is N-carboxymethylchitosan (NCMC).

Even though the derivative binds iron in the meat, the iron is still available for nutrition, according to Vercellotti. NCMC is a water-soluble polysaccharide that has no known allergenic reactions or toxic side effects.

"We were looking at a large number of food gums that have properties of inhibiting iron oxidation," St. Angelo says. "What we had to do was find one that has a chemical "claw" that would effectively grasp iron in meat."

St. Angelo and Vercellotti, research chemists in ARS' Food Flavor Quality Research unit at the Southern Regional Research Center, tested more than 50 gums. Among them was chitosan, a gum made from chitin in crustacean shells and used by industry to clear cloudiness in wine and apple juice during production.

They found that chitosan by itself limited iron oxidation in meat by about 20 to 25 percent compared with an untreated control. NCMC, a modified chitosan, prevented 99 percent of the iron-activated oxidation of meat.

A volunteer, trained taste panel consented to test samples of meat treated with NCMC. Results showed the NCMC virtually eliminated warmed-over flavor. Vercellotti and St. Angelo also determined NCMC's success at inhibiting deterioration of meat-flavor by using gas chromatography/mass spectrometry and chemical measurements of fat degradation.

An ARS patent covers the method of applying NCMC to meats, fish, and poultry to inhibit warmed-over flavor. Vercellotti says when the method is commercialized, the compound could be applied to meats at the slaughterhouse or during food processing by either dusting, spraying, injecting, or dipping. He says it could be developed for consumers into a product similar to seasoning.

Several companies have expressed an interest in the flavor-protecting technology, says William H. Tallent, assistant administrator for ARS' Office of Cooperative Interactions.

Before the technology can be used, it must be approved by the Food and Drug Administration.

"NCMC's greater effectiveness will be extended through commercialization," St. Angelo says. "I could see where NCMC would work well in institutional, airline, or delicatessen foods as well as in fast foods. It could also be used in frozen dinners and dehydrated soups."—By **Bruce Kinzel**, ARS.

John R. Vercellotti and Allen J. St. Angelo are at the Food Flavor Quality Research Unit, Southern Regional Research Center, P.O. Box 19687, New Orleans, LA 70179 (504) 286-4460.

TIM McCABE

Engineers at the Eastern Regional Research Center process potatoes into instant potato flakes. (K-1928-9)

processed into chips, fries, hash browns, instant potatoes, canned potatoes, and other snack and convenience forms.

So it's hard to believe that in the late 1950's potato consumption was declining, and farmers had large surpluses of culled potatoes with low market value. A research team at the Eastern Regional Research Center in Philadelphia came up with the key steps needed to process potatoes into instant potato flakes. The team discovered that potato chemistry requires a three-stage cooking process to retain the desired flavor, texture, and nutrient content. The "Philadelphia" cook (a precooking step that gelatinizes the starch), a cooling step to halt chemical changes in the starch, and the final cooking are the three stages.

Not only did instant potato flakes help boost the potato industry to today's value of $2 billion a year, they opened a new era in high-quality, low-weight, shelf-stable foods. Today about 400 million pounds of potato flakes worth $400 million are produced each year in the United States.

Potato flakes are also used as the main ingredient in reconstituted products such as extruded potato chips. And the key cooking and cooling steps are used in preparation of frozen french fries, which account for nearly half of the potatoes sold by processors. The cooking and cooling give the fries the desirable firm texture.

Matters of Quality

Besides orange juice and french fries, a supermarket's freezing compartments contain an almost infinite variety of other foods. And though we prize these frozen foods mostly for their convenience, they are generally high in nutrient quality, have long-term storability, are safe to eat, and have good flavor, texture, and color. The reliability of these qualities today owes much to research carried out at the Western Regional Research Center in Albany from 1948 into the 1970's.

When the Albany laboratory began its research on quality problems in 1948, commercially frozen foods had already been on the market for 20 years. But the industry wasn't able to explain many aspects of flavor deterioration, color change, nutrient depletion, and bacterial contamination during processing and storage.

The laboratory's studies for the next 25 years evaluated effects of prefreezing treatments and freezing and storage methods. These studies led to procedures for blanching vegetables; enzyme tests to evaluate these procedures; changes in freezing methodology, including individual quick-freezing methods; efficiency of different packaging methods; and data on how fluctuating temperatures affect frozen foods.

The research on fluctuating temperatures resulted in the food indus-

try's "Mark of Zero" campaign. Processors and distributors were alerted to the importance of keeping temperatures below 0°F throughout processing, storage, and distribution.

Other food products and processes developed by the regional centers include thickeners for sauces and gravies in frozen dinners, longer lasting soybean oil, defatted peanuts, and synthesized sour dough bread starter. Then there's explosion-puffed blueberries and mushrooms, protein-enriched pasta, lactose-reduced milk, specialty milk for bread baking, low-fat ripened skim milk cheese, sweetpotato flakes, high-protein rice flour, and dry-peeled fruits and vegetables.

Among the most important contributions have been the results of research on food safety and on processing techniques that minimize production of hazardous wastes.

Results include safer cured meats having lower amounts of potentially carcinogenic nitrosamines, guidelines for safe home canning of tomatoes, and high-volume methods of testing foods for potentially harmful microorganisms and chemical residues.

Textiles and Hides

When most people see a wrinkled shirt, they see bent and crumpled fabric in need of ironing. A textile chemist sees broken and rearranged chemical bonds. Application of heat under pressure (the hot iron) "mends" the bonds and restores the finish.

But ironing clothes is not everyone's favorite occupation, so in the 1940's and 1950's, the textile industry invented fibers that make up into easy-care fabrics, enticing consumers away from fabrics made of cotton. The loss of market was devastating to cotton growers and ginners.

Cotton is a cellulosic fiber; its long molecular chains have no natural

Showing Their Starch Against Insect Pests

Combining sugar and starch with a biocontrol spray system dramatically increases the amount of time the formula remains in place to do its job.

That discovery, made at ARS' Northern Regional Research Center in Peoria, Illinois, means a better adhering, longer lasting, nonchemical solution to some of today's insect crop pests.

In a simulated rainfall test in a greenhouse, entomologist Michael R. McGuire and chemist Baruch S. Shasha found that the sugar-starch encapsulated spray formulation adhered to plant foliage for up to 19 days while conventional spray formulations without the sugar flaked or peeled off within 2 to 4 days.

The researchers also discovered that *Bacillus thuringiensis* (Bt), the biological insecticide used in the test, remained highly active against European corn borers over an 8-day period, killing up to 90 percent of the insects tested.

In the same 8-day interval, other Bt formulations killed only 20 percent of the insects.

"What these findings show, I think, is that we can overcome some of the hurdles of using Bt in the field that we stumbled over before," McGuire says. "For example, sunlight and wash-off by rainfall are two major factors that can reduce the effectiveness or activity of Bt. The spray we used in the greenhouse cuts down on those two problems, especially if some type of sunlight-absorbing compound is added."

Another dilemma: Insects generally reject Bt because of its disagreeable taste. But McGuire says adding a feeding stimulant such as finely milled wheat germ to the sugar-starch spray formulation would keep insects eating long enough to consume a lethal dose and, consequently, might reduce the amount of active material needed for control.

"These results have to be considered preliminary; we have not field-tested to any extent," he says. "But the rainfall tests in the greenhouse suggest that the life of the insecticide can be increased, which means a longer effective time in the field for more insects to feed."

McGuire and Shasha have entered into a cooperative research agreement with Abbott Laboratories of North Chicago, Illinois, to further test the formulation, which the researchers and ARS are patenting. They hope to increase the spray's effectiveness while reducing the cost to produce it.—By **Matt Bosisio,** ARS.

Michael R. McGuire and Baruch S. Shasha are in USDA-ARS Plant Polymer Research, Northern Regional Research Center, 1815 N. University St., Peoria, IL 61604 (309) 685-4011.

bonds, or cross links, between them. Cross links pull the molecular chains back into place and prevent wrinkles. Synthetic fibers are generally designed with built-in cross links.

And though chemical finishes can add cross links to fabrics made of natural fibers, the side effects of some treatments —discoloration, loss of strength, unpleasant feel, manufacturing hazards from some chemicals, and more—can be undesirable.

In the 1950's, scientists at the Southern Regional Research Center in New Orleans developed chemical treatments and processes that give cotton and cotton-blend fabrics the wrinkle-resistant and permanent press qualities of fabrics made wholly from synthetic fibers.

Because this technology minimized undesirable side effects, it was adopted worldwide and is the basis for the permanent press cotton and cotton-blend garments that have been marketed for the past 35 years.

The technology contributed substantially to preservation of cotton's share of the textile fiber market. And it gave consumers the comfort of cotton with most of the convenience of synthetics.

Textile researchers at New Orleans have devised more finishing processes that build on cotton's versatility and make it usable in unprecedented ways. For instance, they've developed chemical treatments that don't wash away during laundering and make cotton fabric flame-retardant.

These treatments are used in protective clothing for military and civilian use. Flame-retardant cotton garments prepared with this technology are used by U.S. astronauts.

The New Orleans center has also given us processes to produce stretch cotton bandages and fabrics, cottons that resist mildew and sunlight, oil-repellent fabrics, and formaldehyde-free permanent press treatments.

Recent developments include a process for treating fibers so they cool in warm temperatures and warm in cool temperatures, and a permanent press treatment for cotton that will allow dyeing of fabric after the treatment—a tremendous advantage in a world where color fashions change rapidly.

Research on wool was done for several years at the Albany center, which came up with treatments for flame- and moth-proofing wool blends and for shrink-proofing wool. Most ARS studies on wool now take place at Philadelphia in the Hides, Leather, and Wool Research unit.

The work at this unit on animal hides has resulted in a new tanning agent. Not only does it enhance the softness of leather and resistance to deterioration caused by perspiration, but the new agent adds stability during repeated wetting and drying

KEITH WELLER

Chemist Mustafa Arifogla examines wool sample just removed from bleaching apparatus. (K-3535-14)

GEORGE ROBINSON

A superslurper flake is swollen into a chunk that is over 99 percent water. Superslurper, made as film, flakes, powder, or mat absorbs about 1,400 times its own weight. (K-0839-1)

and allows tanned hides to withstand washing in hot, soapy water. How useful is the new agent? The leather industry has widely adapted it to produce leathers for work shoes, golf gloves, garments, shoe uppers and linings, and jungle boots for the U.S. military.

And Philadelphia's scientists have not forgotten the leather worker—or the environment. They've developed several techniques and processes to minimize worker and environmental exposure to some of the noxious chemicals used in tanning.

Industrial Products

We usually think of agriculture as the source of food and fiber. But many commodities can also be turned to industrial use. Such products make us less dependent on imports—especially of petroleum. Industrial use not only eliminates wastes but also provides new markets for surplus commodities.

Among the many plant and animal products developed for industrial use by the regional centers are—

- Epoxidized oils. Epoxidized soybean oil accounts for about 38,000 tons of commercially produced epoxidized ester plasticizers a year and provides a major market for soybeans.

- Polyamide resins from dimer acids derived from vegetable oils. They're used as hot-melt adhesives for shoe soles, book bindings, can-seam solders, and packaging and for making drip- and sag-resistant paints. Widely used two-part adhesives (epoxies) are also made from the polyamides developed from this research. U.S. production of polyamides from dimer acids is about 15,000 tons per year.

- Cocoa butter substitutes from cottonseed oil and tallow. Cocoa butter, an important component of

Rice Bran Moves to the Breakfast Table

A flurry of new breads, cereals, and snack foods now on the shelves at U.S. supermarkets feature rice bran as the key ingredient.

Marketers of these new products are aiming them straight at the heart of cholesterol-conscious Americans who are anxious to lower their cholesterol levels by boosting their intake of fiber.

And rice bran, rich in fiber, B vitamins (thiamine, riboflavin, and niacin), vitamin E, and iron, seems ideally suited to do just that.

Bran is the thin outer layer that's removed during milling to produce the familiar white rice kernel. Although it has for many years been a part of health-food products offered by small manufacturers, bran's biggest use has probably been in barns and feedlots, as a component of animal feed.

But studies at ARS's Western Regional Research Center in Albany, California, have done much to move the product out of the barn and onto the breakfast table.

In 1989, four scientists in Albany's Food Quality Research unit—Talwinder S. Kahlon, Faye I. Chow, Mei-Chen M. Chiu, and Antoinette A. Betschart—reported that full-fat rice bran, that is, rice bran with natural rice oil in it, lowered cholesterol levels of young hamsters.

The laboratory animals ate full-fat bran plus a high dose of pure cholesterol with their standard feed. Defatted bran (rice bran with the oil removed) did not significantly alter cholesterol levels of other hamsters.

The cholesterol findings caught the attention of every major Fortune 500 food manufacturer, according to the Rice Council, a trade association based in Houston, Texas.

Published results from three trials with human volunteers attest to bran's cholesterol-lowering effect, says Robin M. Saunders, who leads the Food Quality Research unit. Scientists in Australia, Louisiana, and California conducted those studies.

Saunders and co-researchers started experiments with bran about 10 years ago, at the request of the Agency for International Development, and with funding through USDA's Office of International Cooperation and Development.

The team, which included chemists Robert N. Sayre and Albert P. Mossman, along with many other researchers, met the agency's challenge—to come up with a practical, economical method by which millers and refiners everywhere could thwart a natural enzyme in bran. The enzyme causes bran's oil to turn rancid—making both oil and bran inedible.

The stabilization procedure the California team devised to prevent this relies on forcing freshly milled bran through an extruder, a machine widely used throughout the food processing industry to make products such as breakfast cereals. Heat created during this extrusion deactivates the enzyme.

Saunders has worked with the U.S. rice industry, numerous U.S. food manufacturers, and government officials of China, India, Taiwan, and other countries interested in using rice bran in foods or in retrieving more of bran's light, high-quality oil to refine into salad or cooking oil.—By **Marcia Wood,** ARS.

Scientists mentioned in this article are at the USDA-ARS Food Quality Research unit, Western Regional Research Center, 800 Buchanan St., Albany, CA 94710 (415) 559-5664.

chocolate, is the world's most expensive food fat and is largely imported.

• Superslurper, made from cornstarch, capable of absorbing hundreds of times its weight in water. In the decade since superslurper's discovery, scientists have devised dozens of uses, fostering a growing industry.

• Center scientists have found microorganisms and developed techniques used in making riboflavin (vitamin B_2), vitamin B_{12}, several antibiotics, dextran (a blood plasma extender/substitute), xanthan gum (a thickening and texturizing agent for processed foods, with several industrial uses), beta carotene, biocontrol agents, and many other useful products.

Looking Back, Looking Ahead

Simply listing the research accomplishments of the four regional research centers in the last 50 years would take all the pages of *Agricultural Research* and then some. Much has been basic research, including development of analytical methods widely used by scientists elsewhere and by many regulatory agencies such as USDA's Food Safety and Inspection Service.

Included in these accomplishments are a host of small additions to our lives—a way to heat-transfer prints (such as slogans and pictures) to cotton T-shirts, a method for preserving apple cider longer, and a way to extract sugars from surplus products.

As we near the beginning of a new century, scientists at the regional labs continue to add new products and find new ways of doing things that promise to greatly expand agricultural markets and make daily living easier for us all.—By **Ruth Coy**, ARS. ◆

Fleece As White As Snow—Faster

A more efficient way to make that fleece as white as snow has been developed by Agricultural Research Service scientists.

Urine stain is a major contaminant of domestic wool. The textile industry uses chemical bleaching to whiten wool. For extra whiteness, the initial bleaching must be followed by a second bleaching with another chemical. Now, that dual bleaching can be done in a single bath, says William N. Marmer, a research chemist at ARS' Eastern Regional Research Center in Philadelphia.

Marmer says the new treatment saves energy and time. "We're also using a cheap chemical, instead of the more expensive bleaches used for the second step."

In one comparison test under the Whiteness Index, the textile industry's barometer for judging wool, the current method of treating stained wool had a whiteness number of 15.09, while the new method reached 19.49, more than 4 points higher.

Besides the stain problem, U.S.-produced wool is often contaminated by black pigmented hair. Just one black fiber can be unsightly when wool is processed into light or pastel-colored products.

A process for whitening these black fibers is already established, says Marmer. But, its added expense makes industry turn away from American wool to imports, even though they are usually more costly.

Sheep in America are raised primarily for meat, whereas in some other countries they are specifically bred and raised for their wool.

But now, Marmer says, black fibers can be treated with a variation in the new ARS process for removing urine stains.

Currently, wool containing black fibers is placed in an iron-salt bath, in which iron chemically attaches to pigmented fibers. Then the wool is rinsed of unattached iron and bleached to eliminate pigments. A follow up bleaching with another chemical, such as thiourea dioxide, produces a whiter and more color-stable product.

Marmer and fellow chemist Mustafa Arifoglu at the center's Hides, Leather, and Wool Research unit found that a chemical reaction in the new method eliminates the need of an additional bath for follow up bleaching and the need to dump unused hydrogen peroxide. If thiourea is added to the same bath, it not only decomposes the hydrogen peroxide and removes leftover iron but it is converted into a second bleach in the same bath.

Tests indicate that fiber strength is not affected.

Marmer says that a very white wool, free of pigmented and stained fibers, results from the new process.

ARS has applied for domestic and foreign patent protection for the new process in each variation.—By **Bruce Kinzel**, ARS.

William N. Marmer is at the USDA-ARS Hides, Leather, and Wool Research Unit, Eastern Regional Research Center, 600 East Mermaid Lane, Philadelphia, PA 19118 (215) 233-6585.

No Fence, but the Grass Is Greener

Each summer millions of people visit the museums and monuments on Washington, D.C.'s Capitol Mall and, unfortunately for the grass, walk thousands of feet of lawn ragged and brown by winter.

Most grass is just not tough enough to stand up to that many feet and to the combination of hot summers and cold winters common to the mid-Atlantic region.

But a new grass mixture, developed by the Agricultural Research Service, is now beginning to reach the commercial market. For the Mall and homeowners too, it may be the answer to the search for an easy-to-keep lawn that stays green all year long.

The mixture combines zoysiagrass with a fine textured variety of tall fescue.

Zoysiagrass has been well known since the 1950's as a tough, low maintenance, wear-resistant lawn grass that stays deep green through summer heat and drought.

It only needs to be mowed about one-third as often as most other lawn grasses and forms a thick dense mat as it spreads. But the first frost also causes zoysia to turn an unappealing yellowish brown.

Tall fescue, on the other hand, is a cool season grass that greens up at lower temperatures and goes dormant in the heat—zoysiagrass's mirror image.

Recently retired ARS agronomist Jack J. Murray screened hundreds of varieties of grass to find a type of fescue that was fine-bladed enough to present a pleasing appearance in a lawn and able to hold its own against zoysiagrass.

The denseness to which zoysiagrass spreads allows it to crowd out many weeds, and it can also crowd out many other grasses. Tall fescue is also tough when it comes to standing up to pedestrian traffic, although not as tough as zoysiagrass.

Crowds at one of last year's festivals on the Mall during June and July's heavy rains churned a part of the Mall into a sea of mud wiping out huge patches of the existing grass.

So when Murray brought word of his combination zoysiagrass/tall fescue lawn to the attention of William Newman, chief of maintenance for the National Park Service, Newman was very interested in the tough, easy-care grass.

BOB BJORK

Agronomist Jack Murray, now retired, examines the growth of turfgrass at the Beltsville Agricultural Research Center. This mixture of zoysia and tall fescue is more likely to stay green the year round. (K-2769-1)

In August 1989, the National Park Service replaced more than 200,000 square feet of sod—enough to carpet more than four football fields—with zoysiagrass and overseeded it with tall fescue.

"The zoysia sod we laid took well this summer, and then we overseeded with fescue which did well this past fall," Newman says. "Now we have our fingers crossed that this spring, the fescue will be in good shape and the zoysiagrass will look good when we get to summer and the 98°F and 102°F days."

Newman hopes that the grass mix will stand up to the 2 or 3 million pedestrians who will track across the Mall in the coming year. "Once we see how it does in this summer's traffic, we'll know how much more of the Mall we'll sod with it," Newman says. "We just might have a better chance against some of the bare spots with this though."

Grass Roots Interest

At least one company, Councell's Turf Farm in Goldsboro, Maryland, is already selling the grass combination. "We've planted about 20 acres of the mixture and already sold about 5 of them," says Sherman Councell, who manages the turf farm. "The zoysiagrass browns up in the winter as usual, but the fescue kind of keeps it green. I think this should become very popular."

Interest in zoysiagrass is definitely on the rise, according to agronomist Kevin Morris. He heads the National Turfgrass Evaluation Program, a cooperative program between USDA and the Maryland Turfgrass Council that coordinates testing of newly developed or discovered grass varieties that might be useful as turf.

"There were two big problems with zoysiagrass: the browning and the expense and labor of putting in the sod plugs, which was the only way zoysiagrass came—that's what originally caused people to turn away from it," Morris says.

"Well, some people have started to market a zoysiagrass that can be

PERRY RECH

This past winter, ARS agronomist Kevin Morris (foreground) joined James Patterson (center) and Robert Cook of the U.S. National Park Service in inspecting a section of new zoysiagrass-fescue mixture on the Capitol Mall in Washington, D.C. (K-3549-1)

grown from seed, and with Murray's fescue mixture, you don't have to put up with the brown."

With those two problems out of the way, the grass's low maintenance needs, wear resistance, and ability to tolerate drought will make zoysiagrass very attractive again, particularly in the mid-Atlantic region from southern New Jersey to Georgia and west to Kansas, says Morris.

That's the region called the transition zone—where winters are too cold to consistently grow the warm season grasses such as bermudagrass and summers are too warm for cool season grasses such as Kentucky bluegrass and others.

Next year, Morris's turf grass program is planning to run evaluations of zoysiagrass for the first time. Samples submitted will be evaluated under various management regimes at 25-30 locations across the country.

"We'll compare how well seeded varieties do with the sod plugs and how varieties do under low maintenance versus high maintenance," Morris says.

From the more than 20 varieties that Morris's cooperators are likely to test, only 3 to 5 will ever make it to commercial development. —By **J. Kim Kaplan,** ARS.

Kevin Morris heads the National Turf Grass Evaluation Program, Beltsville Agricultural Research Center, Beltsville, MD 20705 (301) 344-2125. ◆

Busting Rusty Lawns

On cloudy, wet days, when the humidity rises and the temperature cools a bit, zoysiagrass is susceptible to a rust disease caused by *Puccinia zoysiae.* This fungus causes the green blades to shred, turn rusty orange, and suffer premature dieback—leaving ugly, bare spots. It's a problem that two ARS plant pathologists, Martin M. Kulik and Pierre D. Dery, are working to solve.

"A mere heavy dew can cause an outbreak if the rust microorganism is present," says Dery. "Once I even found the only rust in an entire lawn in the cool patch of shade cast by a single tall weed."

They've already found that below 50°F and above 86°F, the rust does not do well.

Kulik says, "What's strangest about the situation in this country is that almost all rusts need to live in at least two separate plant hosts in order to complete their life cycle. But the intermediate host for zoysiagrass rust in the grass's native Far East is an evil-smelling tropical vine called chicken dung creeper, a plant that does not exist in North America.

"This is the host where all of the rust's sexual reproduction takes place. Only asexual spores are formed while the fungus lives in the zoysiagrass."

So the question is where does the rust overwinter, Dery asks. Since only asexual reproduction goes on in the zoysiagrass, the rust may not be very adaptable, he says.

"Without the genetic shuffling that goes with sexual reproduction, defeating the rust may be possible. If we find a way to fight the rust or a zoysia variety that is resistant to it, it isn't likely to mutate very fast and become a problem again the way most of them do," he says.

Martin M. Kulik and Pierre D. Dery are in the USDA-ARS Germplasm Quality and Enhancement Laboratory, Bldg. 001, Beltsville Agricultural Research Center, Beltsville, MD 20705 (301) 344-3358.

Natural Agents Fight Fruit Spoilage

KEITH WELLER

For after-harvest protection against *Rhizopus* rot, plant pathologists Charles Wilson (right) and Randy McLaughlin inoculate Red Haven peaches with the U.S.-7 strain of yeast. (K-3282-7)

Remember, back on the farm, that sickish-sweet, moldy smell that hit you hard as you descended the cellar steps?

When that unforgettable odor came from a barrel of apples, you knew they had been hit by storage rot.

While your nose might not be able to differentiate between one rotten apple and another, there are several different storage rots that attack fruit and vegetables.

Each is caused by a specific microorganism, and each is potentially costly to fruit producers and greengrocers. Throughout the world, about a fourth of the fruit harvested is lost to storage diseases.

In the United States, fungicides have for many years been used to keep these microorganisms under control, but these chemicals have not always been effective.

Worse, they can be hazardous to the health of humans and detrimental to the environment.

This concern is evidenced by the Environmental Protection Agency's (EPA) recent proposal to partially ban ethylene bisdithiocarbamates (EBDC's), the most widely used group of fungicides.

About one-third of all fruits and vegetables produced in the United States are currently treated with EBDC's to control fungus and mildew. Production of some of the commodities that need these fungicides could be slowed down or stopped if alternatives are not found.

"For several decades, our scientists have been looking for biologically based alternatives to chemical pesticides," says Waldemar Klassen, ARS associate deputy administrator.

Their perseverance is paying off, in the form of new, naturally occurring biocontrol agents—yeasts and bacteria that protect against storage rots.

WOJCIECH JANISIEWICZ

From the untreated pears on left to the unspoiled ones on the right, varying concentrations of a natural fungicide prove its worth. Each pear was inoculated with the fungus that causes blue mold and kept in cold storage 30 days. (K-3552-1)

"Public concern for food free of pesticide residues has opened up new opportunities for biological control," says ARS' Charles L. Wilson, a plant pathologist stationed at Kearneysville, West Virginia. "No longer is biocontrol considered a last resort."

At the Appalachian Fruit Research Laboratory, Wilson leads a research team dedicated to finding major weapons other than chemicals to control postharvest fruit losses.

"In a lot of cases, biological control means finding a microorganism that produces antibiotics to control diseases. But we're doing something different. We're working with organisms that naturally occur on fruit and protect it without producing antibiotics," Wilson says.

These organisms are called antagonists because they fight pathogens that invade fruit wounds. Fruits and vegetables get most postharvest infections through wounds in surface tissue. These wound sites then become the battleground for pathogens and antagonists.

Wilson and Israeli scientist Edo Chalutz have discovered a new antagonist—a strain of yeast, now named US-7, that effectively controls fruit rot. Chalutz is a scientist with the Institute for Technology and Storage of Agricultural Products in Bet Dagan, Israel.

US-7 affects pathogens on the surface of fruit by monopolizing nutrients or by making the infection site untenable for the pathogen in some unknown way.

The Lemon's Legacy

"We found this organism in washings from the surface of lemons," Wilson says. "We noticed that after we washed the fruit, it no longer stored as well. That led us to suspect a natural organism was involved."

In tests, US-7 proved effective against diseases on citrus, peaches, grapes, and tomatoes, as well as mold found on stored wheats. It may be applied either before or after harvest.

The yeast worked on three fruit rot pathogens and against fungi responsible for green mold, blue mold, and sour rot of citrus.

Then why isn't this environmentally safe replacement for fungicides already on the market?

Well, it's getting there. ARS has entered a 3-year Cooperative Research and Development Agreement with FRM, a binational company, to mass-produce US-7 and conduct pilot tests on how to apply it. Wilson and Chalutz have a patent.

"We're thinking of several ways to apply the yeast," Wilson says. "It could be formulated as a powder, encapsulated and dusted on, or it could be mixed with a wax and sprayed or brushed on."

Once Wilson, Chalutz, and FRM have developed and successfully tested an effective preparation, they will apply for EPA approval.

Yeast strain US-7 is but one antagonist against postharvest diseases that Kearneysville scientists have discovered. Plant pathologist Wojciech J. Janisiewicz has isolated a bacterium from apples that completely controls blue mold, a major disease of stored apples.

The antagonistic bacterium, *Pseudomonas syringae pv. lachrymans,* which has been tested for more than 4 years, works at room temperature and in cold storage as well.

"The amazing thing about this bacterium is that it grows exponentially in cold storage, making it ideal against storage rots," Janisiewicz says. Most bacteria grow better in warm, moist environments.

A Welcome Discovery

This news is especially timely. Benomyl, a fungicide used to protect stored apples and pears from molds, was discontinued for postharvest use in 1989. Captan and EBDCs, registered chemical alternatives, are both slated for discontinuance by 1991 for most postharvest uses.

Janisiewicz has applied for a patent for *P. syringae pv. lachrymans.* It appears to trigger an inherent resistance in the fruit to mold. Just how and why, however, are still mysteries that further research will probe.

Robert A. Spotts, plant pathologist with Oregon State University's Mid-Columbia Agricultural Research and Extension Center, is testing the antagonists against storage decay of pears. Spotts is located in the Hood River area of Oregon, where most of the nation's pears are produced. He says, "The strain we just tested gave us 100 percent control over gray and blue mold."

This is even more important since decay pathogens are showing resistance to the only other chemicals available to fight storage rots once postharvest use of benomyl was banned. "We desperately need biocontrol for storage molds," he says. "These antagonists have that potential. Commercialization will be difficult, but worth the effort."

The difficulty lies in the time, effort, and money involved in finding biocontrol agents and verifying their effectiveness. Then there must be a probable market before companies will invest in developing them.

Biocontrols identified for postharvest diseases so far affect only a portion of the total pesticide market. But if a day arrives when principal fungicides are no longer available and producers find themselves with no suitable replacements, the market dynamics may well change.

Janisiewicz has also applied for a patent for another antagonistic bacterium, *Pseudomonas cepacia,* that has also proven successful against storage rots in fruit *[See* Agricultural Research, *November 1989, pp. 4-8].*

Because fungi that cause storage rots grow more slowly than yeast and bacteria, they usually make less desirable biocontrol agents. *Acremonium breve,* however, is an exception.

"This fungus grows like a yeast, and turns out to be a tough antagonist that resists various environmental conditions," Janisiewicz says. He has applied for a patent.

Also isolated from apple leaves and fruit, *A. breve* gave total protection against gray mold caused by *Botrytis cinerea.* Botrytis is a fungal rot that can infect adjacent fruit in storage. Captan is now used against this disease, which had previously been controlled with benomyl.

Janisiewicz has applied for funds to run a pilot test using these organisms. He plans to apply them in both powder and wet formulations.

He says packinghouses have dip tanks and drenching equipment for chemical applications that could be used to apply the antagonists.

"We hope to eventually have a mixture of antagonists to control multiple diseases," Janisiewicz says.—By **Doris Sanchez,** ARS.

Charles L. Wilson and Wojciech J. Janisiewicz are at the USDA-ARS Appalachian Fruit Research Station, 45 Wiltshire Road, Kearneysville, WV 25430 (304) 725-3451. ◆

Searching for Natural Agents

Former Kearneysville plant pathologist P. Lawrence Pusey, now stationed at ARS' Southeastern Fruit and Tree Nut Research Laboratory in Byron, Georgia, has patented a bacterial antagonist that controls brown rot of stone fruit.

Pusey completed pilot tests in 1986 that showed good control under commercial conditions. The patent has since been licensed.

Pusey says the Fermenta Plant Protection Company, Painesville, Ohio, has had a nonexclusive license for 3 years to produce the antagonist *Bacillus subtilis.*

Other ARS scientists researching biological ways to control plant pests include George Papavizas, Beltsville, Maryland; R. J. Cook, Pullman, Washington; Rodney G. Roberts, Wenatchee, Washington; Robert G. Linderman and Joyce Loper, Corvallis, Oregon; Charles R. Howell, College Station, Texas; and Harvey W. Spurr, Oxford, North Carolina.

Patents: Creative Problem Solving In Action

A drug made from the bark of an evergreen tree native to the Pacific Northwest has been used to successfully treat cancer in clinical trials.

New treatments are always welcome in the fight against cancer. But producing the drug, called taxol, which comes from the Pacific yew tree, has created a heavy demand for this slow-growing tree.

Harvesting the bark means sacrificing the trees, which are in short supply and take nearly 50 years to grow before they are practical to harvest. Using standard technology, it takes up to 20,000 pounds of bark from 2,000-4,000 trees to produce 1 kilogram of the drug.

Also, the yew tree grows in older forests that are being harvested for timber. It is feared the change in habitat after timber harvest may affect the yew tree's ability to regrow.

Taxol is too complicated a chemical compound to synthesize.

But Agricultural Research Service scientists have developed and are patenting a method to grow the taxol-producing cells without growing the whole tree.

ARS biologist Alice Christen and her team at the Southern Regional Research Center in New Orleans used tissue-culture techniques to grow just the taxol-producing cells of the yew tree in the laboratory.

"The cells grow very slowly in culture," Christen says. "But the trees grow even slower. The cells will produce usable amounts of taxol."

The team is working on ways to scale up their method to meet commercial needs. ARS is negotiating with private firms on research and development and licensing agreements.

Taxol-culture growth is one of 61 patent applications stemming from ARS research that were filed from October 1988 through September 1989. Forty-seven patents were granted in the same period. Some of ARS' patented inventions are being licensed by private industry and are in use.

"The patent program is the best example of transferring the technology developed by our scientists into the marketplace," says Ann Whitehead, coordinator of the ARS' National Patent Program. "These inventions involve new and higher quality products, prevention of diseases in plants and animals, and natural control of pests that harm our environment and food supply."

Inventive Tendencies

Already in the 6 months beginning October 1989, 17 patent applications have been filed and 15 patents granted.

One of those promising patents filed this year comes from Phillip H. Klesius, a microbiologist with ARS' Regional Parasite Research unit in Auburn, Alabama. Klesius has found a way to pinpoint the presence of *Edwardsiella ictaluri*, a bacterium responsible for up to 40 percent of all catfish diseases in the southeastern United States.

A protein from the bacterium can be used to detect outbreaks of this in ponds. The protein, called an immunodominant antigen, might also be used someday as a vaccine against *E. ictaluri*, Klesius says.

He says the protein can be mixed with blood from live fish to reveal infection in 4 to 6 hours, giving farmers a chance to treat fish with medicated feed. Several companies are interested in licensing Klesius' patent and hope to develop a diagnostic kit that could provide answers in minutes right at pondside.

"The ability to diagnose this problem could save millions of pounds of catfish losses," he says.

Previous detection of *E. ictaluri* usually came too late after farmers found their crop floating "belly-up."

As a vaccine, the protein might be injected into fish, or absorbed as the fish soak in medication-laced water, he says.

When patented ARS research increases, so do licensing fees and royalties paid to the agency. Twenty-two royalty-bearing licenses were granted in fiscal year 1989, increasing the income from licensed agency-patented inventions from $7,300 in 1981 to more than $417,000 in 1989.

As ARS expands its licensing revenue, these dollars will be used to reward scientists, pay patent maintenance fees and foreign patent fees, and return money to research programs that originated the patent. Fiscal year 1990 is expected to be the first year in which licensing revenues will exceed patent and licensing expenses, Whitehead says.

Some of this patented research has helped add jobs and new income in the private business sector. In turn, the payoff to the consumer is in higher quality fabrics and foods; a safer, more convenient food supply; and even contributions to medicine.

"ARS research is committed to solving agricultural problems that affect farmers, workers, and consumers," Whitehead says. "Our patented research is the keystone of the technology transfer program."—By **Bruce Kinzel, Sandy Miller Hays,** and **J. Kim Kaplan,** ARS.

For information on licensing patents or to receive a catalog of USDA patents, contact Ann Whitehead, Coordinator, National Patent Program, USDA-ARS, Room 401, Bldg. 005, Beltsville, MD 20705 (301) 344-2786. ◆

Frozen Milk—Low Cholesterol, Tastes Great

Compromising flavor for low-fat milk could become a thing of the past. Frozen milk concentrate developed by U.S. Department of Agriculture scientists combines reconstituted milk with the texture of whole milk but with the cholesterol content of skim milk.

Even if cholesterol isn't a concern, consider the convenience of reaching into your freezer to make up a quart of milk when your cake mix falls a cup shy.

The milk concentrate is the brainchild of George N. Bookwalter and Steven A. Lyle of the Agricultural Research Service. Bookwalter, a research food technologist, and Lyle, a physical science technician, got the idea while working on a formulation to provide fluid milk for victims of the Chernobyl nuclear accident.

Several companies are interested in commercializing the frozen milk technology now patented by ARS.

Past attempts at a frozen concentrate resulted in difficulties in reconstituting the butterfat of milk. Bookwalter found that combining nonfat dry milk with a critical level of water, then blending cholesterol-free oil, such as soybean, corn, or peanut oil, overcomes the need for emulsifiers and homogenizers.

"The key thing is you don't get oil separation even without using a homogenizer," Bookwalter says. "The oil gives it much greater palatability than skim milk."

Reconstituting the concentrate is easy. A pint of concentrate makes 2 quarts of milk. And it can be mixed with a spoon if fully defrosted or with a food blender if still partially frozen. Microwaving for 3 to 4 minutes on low power hastens thawing without affecting the milk's quality.

An 8-ounce serving of reconstituted milk from concentrate contains just 4 milligrams of cholesterol compared with 33 milligrams found in whole milk. Skim milk and the new milk beverage have the same cholesterol level.

Composition of the frozen milk is variable. Current formulations are adjusted so that the reconstituted milk product contains a minimum of 8.25 percent milk solids and up to 2 percent vegetable oil.

Although the concentrate must be kept frozen in storage, it occupies only about a fourth of the storage area that fluid milk requires. Transportation costs for handling the new product would also decrease. It costs about 50 cents to ship a gallon of fluid milk, which is 4 times heavier than the concentrate, from Wisconsin to Miami.

The frozen concentrate could even be tailor-made for lactose-intolerant consumers, Bookwalter says. The mixture might include additives such as flavor and nutrients.

"I really see this as a specialty market," Bookwalter adds. "It's all up to the consumer."—By **Bruce Kinzel**, ARS.

George Bookwalter is in the USDA-ARS Plant Protein Research Unit, Northern Regional Research Center, 1815 N. University St., Peoria, IL 61604 (309) 685-4011. ◆

BOB NICHOLS

Secretary of Agriculture Clayton Yeutter (seated) sips approvingly on milk prepared from frozen concentrate, a new process developed by ARS food technologist George Bookwalter and physical science technician Steven Lyle (not shown). (K-3537-1)

Research Fuels Local Economies

Seven years ago, Central Illinois Manufacturing Co., was producing pressure caps for fuel tanks with just a handful of employees. Today, thanks to a new product line based on ARS cornstarch research, the company employs 85 and has helped revitalize the Bement, Illinois, agricultural community.

CIMCo's blue aluminum buildings house assembly lines that punch out fuel filters for gas tanks and pumps. The filters are made with superslurper, a substance that can absorb 1,400 times its weight in moisture.

Developed from cornstarch by a team of ARS scientists led by chemist William Doane in 1974, superslurper has since been used in body powders, diapers, absorbent soft goods, batteries, and soil additives.

The Corporate Slurp

Hydrosorb is the company's superslurper product. It removes water from fuel as it passes through the filter. Last year, CIMCo produced 40,000 filters a month. This year, because business is jumping, the $2 million Hydrosorb enterprise is projected to do considerably better, according to Will Ayers, president of the company. Sales may reach 3 million dollars.

"The filter business is very competitive," he says. "You're competing with the big guys. The only way the little guys are going to survive is through research. With Hydrosorb, we've got a good, viable product, and we want to keep it going."

As the leading private employer in town, and the second largest in Piatt County, the company's success is good for the community. The former railroad town in east-central Illinois is typical mid-America: small shops, well-kept neighborhoods, a grain company alongside the tracks. Until a few years ago, whatever direction the farm economy took, Bement often followed along.

But CIMCo is changing that in some ways. Ayers recently bought two historical buildings slated for destruction and turned one into a department store. The other is being prepared for new businesses.

"These kinds of things bring people to town and help brighten the town," he says. "We all have to work together for success. That way it trickles down for everyone."

Research by ARS scientists continues to pay dividends for agriculture and rural America. Through the transfer of technology, ideas sown in the lab are blossoming into jobs and prosperity for small towns, farms, and even whole regions that once struggled to survive. Take, for example, cotton in North Carolina. Fifteen years ago, it was on its way out. The boll weevil had turned one of the leading cotton-producing states into a small-time producer. The statewide area harvested, which once peaked at 1 million acres, had dropped dramatically to about 42,000.

Cotton acreage is expected to increase this year, largely because of a boll weevil pheromone trap, developed by ARS researchers, that helps cotton growers monitor when and where the insect is present in fields. (K-2688-4)

Cotton Revival

The area is now in the midst of a bullish recovery. According to a former ARS scientist, Willard Dickerson, now plant pest administrator with the North Carolina Department of Agriculture, cotton acreage is expected to reach 130,000 this year. This is largely because of a weevil pheromone trap he and other ARS researchers designed and perfected.

The trap, which helps cotton growers monitor when the insect is present in fields, has meant $60 more per acre to cotton growers because of reduced insect damage and fewer insecticide applications.

"And it has also meant more jobs," Dickerson says. "In the last 10 years, 20 new cotton gins have been built in North Carolina, each employing 10 to 20 people on a seasonal basis."

The traps are a key element of the Southeastern Boll Weevil Eradication Program, a cooperative effort of cotton growers, the U.S. Department of Agriculture, and state and local agriculture offices. The program, in place since 1978, is credited with chasing the weevil out of the Carolinas.

The Southeastern Boll Weevil Eradication Foundation, a group of cotton growers, holds an exclusive license to manufacture the trap. Dickerson says the foundation made 1.2 million traps in 1989 and will easily put out another 1 million this

Through the transfer of technology, ideas sown in the lab are blossoming into jobs and prosperity for small towns, and regions that once struggled to survive.

KEITH WELLER

Highly absorbent, superslurper was developed from cornstarch by a team of ARS scientists. Today, it's found in body powders, absorption dressings, oil filters, and soil additives, as well as diapers and batteries. (K-3297-1)

year. The devices, used in every cottonfield in North Carolina, are provided to growers at cost.

Beetle Traps

On the other side of the United States, another piece of agency research is producing results. Consep Membranes, Inc., of Bend, Oregon, manufactures Japanese beetle traps that use an ARS-discovered pheromone to attract the insects.

Alan Guggenheim, vice president for corporate development and operations, says the company sells the traps to garden supply businesses and hardware stores, and may eventually move them and other products onto supermarket shelves.

While not wanting to divulge production secrets, he notes that the pheromone was vital to the success of the trap, "and that trap represents a significant portion of our consumer product line."

Bend has a forest-based economy that slips into recession about every 5 years, Guggenheim says. But with the Japanese beetle trap and other products, the company has avoided the effects of recession and provided stability in the west-central Oregon community.

Jasmine Rice

A new rice may perk up prospects for growers in parts of Texas, Louisiana, Arkansas, and Mississippi. ARS plant breeder Charles N. Bollich says Jasmine 85, an aromatic rice variety from the Philippines, could provide southern growers with a small but healthy market niche that is rapidly expanding.

Over 100,000 tons of aromatic rices are imported annually to meet the demand of Southeast Asians and others now living in the United States. That source could be readily replaced by 40,000 to 50,000 acres of domestically grown Jasmine 85, first grown in Bollich's greenhouse in 1987.

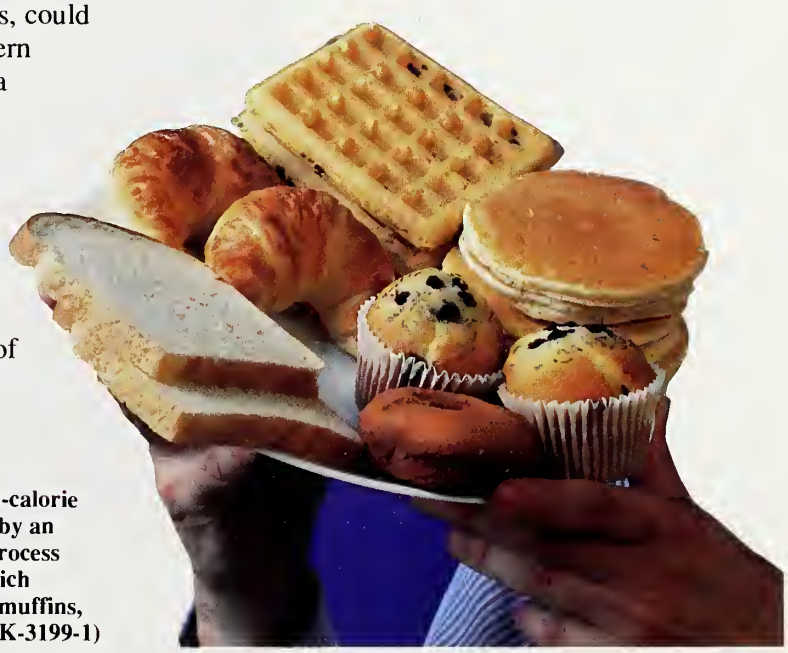
"It's a significant amount of rice," Bollich says, "and growing it here may increase domestic consumption."

Fiber Flour

The future appears at least equally bright for a small family business in Mt. Pulaski, Illinois. Mt. Pulaski Products, Inc., produces a no-calorie dietary fiber from an ARS-patented process. The product will be sold to firms making fiber-rich bread, cereals, cake mixes, doughnuts, and other prepared foods.

R. Scott Steinfort, president and general manager, says the new venture, begun in 1989, is expected to create 25 to 30 new jobs and double the company's volume of business.

The high-fiber flour is



A high-fiber, no-calorie flour developed by an ARS-patented process produces fiber-rich breads, waffles, muffins, and pancakes. (K-3199-1)

made from the filmy outer portion of corncobs. The central Illinois company will be buying cobs in a 60- to 100-mile radius of Mt. Pulaski, adding an estimated $5 million to the rural economy.

The Du Pont Co., of Wilmington, Delaware, is also in the fiber business. Using the same patent, the company makes an oat fiber flour from oat hulls to give prepared foods a fiber boost. Canadian Harvest USA, a joint partnership of Du Pont and ConAgra, Inc., of Omaha, Nebraska, produces the fiber at a recently built factory in Cambridge, Minnesota, about 40 miles north of Minneapolis.

Several other ARS outreach projects have fared well.

• Polysorb, Inc., of Smelterville, Idaho, makes medical and recreational coldpacks and other products from superslurper. The technology led to the creation of 50 new jobs and the revitalization of a closed-down bowling alley and recreation center in a former mining town where unemployment is high.

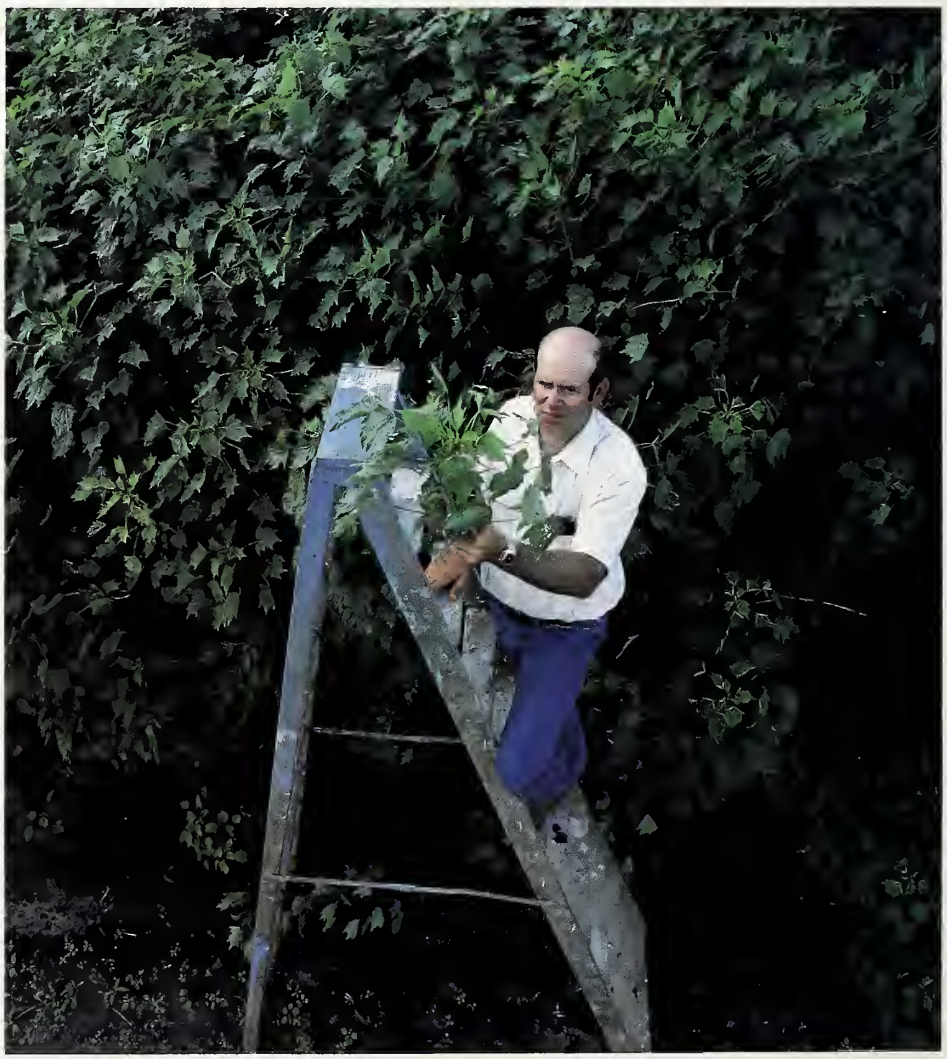
• Three Rivers Produce in southeastern Oklahoma is reaping the benefits of ARS know-how. The vegetable packing and marketing operation is concerned with providing area farmers with alternative crops. With the help of ARS plant specialists, Three Rivers saw the harvest of alternative crops go from 88,000 pounds in 1985 to 2 million pounds in 1987.

• The Kenaf Paper Company of Texas, a consortium of businesses, plans to erect a kenaf-based newsprint mill in south Texas later this year. Once under full operation in 1991, the $35 million plant will employ 160 and process annually about 30,000 tons of newsprint from kenaf grown by area farmers. Kenaf, a fast-growing annual that originated in Africa, was studied by ARS scientists in the 1960s and 1970s as a supplemental source of paper fiber.

• Tri Bio Laboratories of State College, Pennsylvania, produced and sold more than 400 million doses of Marek's disease vaccine in 1989. The vaccine, to combat Marek's disease in poultry, is based on an ARS invention. The company is also working toward a USDA license to produce hemorrhagic enteritis vaccine, another ARS invention. Tri Bio Laboratories has grown to 63 employees since it first opened its doors in 1972 with just 3.—By **Matt Bosisio,** ARS.

For information on licensing patents or to receive a catalog of USDA patents, contact Ann Whitehead, coordinator, National Patent Program, USDA-ARS, Room 401, Bldg. 005, Beltsville, MD 20705 (301) 344-2786. ◆

DAVID NANCE



Standing near the top of a 14-foot ladder, Andy Scott, director of research at Rio Farms in Texas' Rio Grande Valley examines kenaf plants. Both the pulpy center and fibrous exterior of this bamboolike woody plant are used to produce newsprint and other fiber products. (K-2975-9)

Tracking Iron in Children

Even a mild case of iron deficiency can be detected in the early stages with a new test that can easily be administered to infants and children. The test requires only a few drops of blood, so a pinprick in the finger should get an adequate amount, says Helmut A. Huebers, a research chemist formerly at the ARS Children's Nutrition Research Center in Houston, Texas. Huebers began to develop the test at the University of Washington.

The test counts the number of receptors of the plasma iron-binding protein, transferrin. Transferrin delivers iron to body cells through the bloodstream and releases iron inside the cell after passing through specific transferrin receptors.

"The more receptors present on the cell surface of a hemoglobin-producing cell, the greater the need for iron inside the cell. The number of receptors in plasma (fluid part of blood) reflects the total number of membrane transferrin receptors within the body. By counting the receptors, we can help diagnose iron deficiency and factors that would eventually lead to iron deficiency," says Huebers.

Iron deficiency is a worldwide problem. Children and women are particularly vulnerable to iron deficiency, which results from rapid growth, inadequate dietary intake, and blood loss. Adolescents who are in a rapid stage of growth and have inadequate diets may also be at risk.

Usually, laboratory tests for iron deficiency rely heavily on measuring hemoglobin concentration in red blood cells. With such tests, however, abnormalities don't show up until iron deficiency or iron-deficiency anemia are already in advanced stages.

Huebers' test could also be used by nutritionists to study the body's need for iron at varying stages of development for the purpose of changing dietary recommendations.

Using an ELISA (enzyme-linked immunosorbent assay) test, Huebers compared the number of transferrin receptors from both normal adults and those with problems making red blood cells, a function of the bone marrow.

"Plasma receptors have a constant relationship to tissue receptors, and their number reflects the rate of red cell production," says Huebers.

The test's possible applications include diagnosing the severity of aplastic anemia—a condition in which the bone marrow fails to make red blood cells. It can also help diagnose a disease in which anemia is accompanied by an overproduction of red blood cells.

Known as beta-thalassemia, it afflicts children in Italy and other countries bounding the Mediterranean as well as those in Thailand.

The ARS Children's Nutrition Research Center is operated by Baylor College of Medicine, in cooperation with Texas Children's Hospital in Houston.—**By Linda Cooke,** ARS.

For additional information on this research, contact Buford L. Nichols at USDA-ARS Children's Nutrition Research Center, 1100 Bates St., Houston, TX 77030 (713) 798-7000. ◆

Scratching For Better Poultry Vaccines

Avian influenza virus is ubiquitous in nature and most commonly affects waterfowl. Occasionally the virus infects turkeys and chickens, resulting in a range of symptoms from mild upper respiratory infections to attacking virtually every part of the body.

The more virulent strains can result in the destruction of whole flocks and the quarantining of fowl-producing areas or states. In 1983-84, the federal government spent $63 million to eradicate the disease from poultry in areas of Pennsylvania and Virginia.

"We know very little about the effect avian influenza virus has on the birds' immune system," says ARS microbiologist Peter S. Holt in Athens, Georgia. "We do know that certain cells called lymphocytes play significant roles in the immune systems of most animal species."

T-lymphocytes, a class of white blood cells, are known as the gatekeepers of the immune system. When activated by invading organisms, they produce hormones that direct other body cells to make the antibodies that are the body's primary defense against infection. T-lymphocytes also kill invaders themselves or direct other cells to do the job.

"We wanted to see what effect killed avian influenza virus would have on chicken lymphocyte activation," says Holt. "So we grew the cells in tissue culture. These cells came from the blood of specially grown pathogen-free chickens."

When the inactivated virus and an immune-system-stimulating compound—concanavalin A—was added to the culture, lymphocyte activity increased 150 percent compared to cultures that received just concanavalin A. The cells also started to produce more of the hormones that normally mobilize the bird's immune system.

The less virus added, the fewer lymphocytes reacted. Thus it appears that the virus or part of it can increase the activation of the lymphocytes, says Holt.

Vaccines for avian influenza usually contain inactivated virus as an antigen. When the vaccine is inoculated into poultry, the birds' immune system reacts by producing antibodies to the influenza antigen. The antibodies help protect against infection. These tests show that the inactivated virus could help increase the effectiveness of vaccines against other diseases of poultry.

"This interplay between avian influenza virus, lymphocytes, and an immune-system-stimulating compound may give us a better understanding of the immune systems of domestic fowl," says Holt. "It may lead us to an understanding of lymphocytes and how they react with various agents that stimulate them. We also hope to learn how the different lymphocytes interact with each other."—By **Vince Mazzola,** ARS.

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